GEORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[x] ORIGINAL [ ] REVISION NO. ______

Project No. E-26-606 GTRI/~~GIT~~ DATE 4 /30 / 84

Project Director: Dr. Bernd Kahn School/~~Lab~~ NE

Sponsor: Georgia Department of Natural Resources; Environmental Protection Division;
Atlanta, GA 30334

Type Agreement: Contract dtd. 4/15/84

Award Period: From 4/15/84 To 12/30/84 (Performance) 12/30/84 (Reports)

Sponsor Amount:

	This Change	Total to Date
Estimated:	$ 2,000	$ 2,000
Funded:	$ 2,000	$ 2,000

Cost Sharing Amount: $ ______ Cost Sharing No: ______

Title: Technical Consultation Concerning Radiological Aspects of High level Radioactive Waste Repository in Georgia Crystalline Rock

ADMINISTRATIVE DATA OCA Contact Lynn Boyd x4820

1) Sponsor Technical Contact:

Dr. William McClemore
Georgia Geological Survey
Environmental Protection Division
Georgia Department of Natural Resources
19 Martin Luther King Dr., SW Rm. 400
Atlanta, GA 30334 404/656-3214

2) Sponsor Admin/Contractual Matters:

Mr. Earl A. Shapiro
Georgia Geological Survey
Environmental Protection Division
Georgia Department of Natural Resources
19 Martin Luther King Dr., SW Rm. 400
Atlanta, GA 30334 404/656-3214

Defense Priority Rating: n/a Military Security Classification: n/a
(or) Company/Industrial Proprietary: n/a

RESTRICTIONS

See Attached ______ Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with n/a

COMMENTS:

MAY 1984 RECEIVED Research Reports Office

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Project Director	Procurement/EES Supply Services	GTRI
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Accounting	Research Communications (2)	Other Newton

FORM OCA 4:383

GEORGIA INSTITUTE OF TECHNOLOGY　　　　OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

5143

Date 9/19/85

Project No. E-26-606　　　　School/~~Lab~~ NE

Includes Subproject No.(s) N/A

Project Director(s) Bernd Kahn　　　　GTRC ~~GIT~~

Sponsor Georgia Department of Natural Resources; Environmental Protection, Atlanta, GA

Title Technical Consultation Concerning Radiological Aspects of High Level Radioactive Waste Repository in Georgia Crystalline Rock

Effective Completion Date: 12/30/84 (Performance) 12/30/84 (Reports)

Grant/Contract Closeout Actions Remaining:

- [ ] None
- [ ] Final Invoice or Final Fiscal Report　　Already submitted.
- [ ] Closing Documents
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other ______

Continues Project No. ______　　Continued by Project No. ______

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FORM OCA 69.285

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF INTERDISCIPLINARY PROGRAMS
205 OLD CIVIL ENGINEERING BUILDING
ATLANTA, GEORGIA 30332

ENVIRONMENTAL RESOURCES CENTER
(404) 894-2375

BIOENGINEERING CENTER
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E-26-606

October 24, 1984

Dr. Earl Shapiro
Assistant State Geologist
Georgia Geologic Survey
Environmental Protection Division
Room 400
19 Martin Luther King, Jr. Drive, SW
Atlanta, GA. 30334

Dear Dr. Shapiro:

In response to your request by telephone that I prepare a description of defense nuclear high level waste, including a comparison with high level waste from the commercial nuclear power cycle, I have written the enclosed report, "Defense Nuclear High Level Waste Characteristics." This report is in partial fulfillment of the contract "Technical Consultation Concerning Radiological Aspects of High Level Radioactive Waste Repository in Georgia Crystalline Rock," Georgia Tech No. E-25-633.

Please let me know if I can provide further information on this matter or associated topics.

Sincerely yours,

Bernd Kahn

BK/pad

Enc.
cc: Office of Contract Administration

Defense Nuclear High Level Waste Characteristics

Defense nuclear high level waste (HLW) is generated by reprocessing defense production reactor fuel. Initially, it is the acidic aqueous stream from the first-cycle extraction system in a fuel reprocessing plant. Subsequently, its physical state can be changed by crystallization due to evaporation, precipitation, and solidification associated with calcining and preparing a glass. This type of waste, together with HLW from experimental reactor programs, has been stored and processed by the Department of Energy at three locations: the Savannah River Plant at Aiken SC, the Idaho National Engineering Laboratory at Idaho Falls ID, and the Hanford complex at Richland WA. At the Savannah River Plant and Hanford, the liquid waste is made alkaline and separated by precipitation procedures. It is now stored in tanks in several forms, described as liquid, slurry, and salt cake. At the Idaho National Engineering Laboratory, the waste is calcined to a granular solid.

Commercial HLW at present consists only of some acidic and alkaline liquids plus solid phases stored in tanks at West Valley NY. Two commercial reprocessing plants were built in the U.S. for dissolving fuel from commercial nuclear power plants and recovering fissionable material, but neither plant has been placed in operation. It is not believed that either plant will ever operate. At present and in the immediate future, spent fuel elements from commercial nuclear power stations will be stored for an indefinite period. Plans for reprocessing them and estimates of resulting HLW amounts and volumes are available.

The amounts of defense and commercial HLW existing in 1982 are summarized in Table 1, together with the expected amounts of these wastes over the next 35 years. Volumes are in units of 1000 cubic meters and radioactivity amounts are in megacuries. These amounts from existing HLW and anticipated processing are compared to future commercial waste if processing of the latter is begun and follows an assumed plan. Calcining and conversion to glass are assumed for all commercial waste from 1985 on, hence all volumes refer to glass. The amounts of defense HLW indicated in parentheses in Table 1 also are expected to be converted to glass and reduced in volume by the indicated times; the other HLW will remain in tanks. For this time period, defense HLW is expected to comprise the larger volume of HLW in glass form, although the amount of radioactivity in this form will be less than in commercial HLW.

The distribution of defense HLW by location and form in 1982 is presented in Table 2. The largest radioactivity amount is in the form of sludge at the Savannah River Plant. Note that a relatively large fraction of the radioactivity total has been separated into Sr-90 and Cs-137 capsules at Hanford and need not be considered for further processing and disposal.

Table 3 gives the major radionuclide constitutents in these wastes. The long-lived radionuclides Sr-90 (half life 28.8 years) and Cs-137 (30.2 years) contribute most of the radoactivity, and the shorter-lived radionuclides, such as Zr-95, Nb-95, Ru-106, and Ce-144, will further decrease by radioactive decay as contributors to the total radioactivity. The listed radioactivity amount for radionuclides with radioactive progeny includes their progeny; e.g., the value for Sr-90 includes Y-90. Some values are also available for radionuclides at lesser radioactivity level, as indicated in footnote 1, but reported analyses are not sufficiently complete to calculate levels of all longer-lived radionuclides that will remain after Sr-90 and Cs-137 have decayed.

Some chemical characteristics of the defense HLW in various forms are given in Table 4. The chemical contents are quite variable in wastes at the Savannah River Plant and Hanford, hence these are average or typical values. For the Idaho National Engineering Laboratory, predicted contents are given for a process to be placed into routine operation in 1985, but data for current wastes are available.

For comparison, the expected typical compositions in liquid commercial HLW and in the glass to be produced from it are given in Table 5. The concentration in glass is higher by about a factor of two than for the future commercial waste in Table 1, probably because of a shorter decay interval between irradiation and reprocessing. In comparison, the stored defense HLW described in Table 3 has a much higher fraction of Ce-144 (plus Pr-144) and a much lower fraction of radionuclides combined under "other" in Table 5.

The information presented here has been extracted from reference 1. This report compiled information for the various types of waste, including transuranium and low-level wastes, as of 1983.

Reference

1. Oak Ridge National Laboratory, 1983, "Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics", US Dept. of Energy Report DOE/NE-0017/2.

Bernd Kahn
October 1984

Table 1

Present and Projected Amounts of Stored HLW

Date	Defense		Nuclear Fuel Services		Future Commercial	
	Vol., $10^3 m^3$	Activity, MCi	Vol., $10^3 m^3$	Activity, MCi	Vol., $10^3 m^3$	Activity, MCi
1982	309	1,386	2.3	36	0	0
1985	300	1,607	0.2	33	0	0
1990	315 (0.3)	1,696 (1.5%)	0.2	29	0.14	179
2000	318 (3.6)	1,570 (16%)	0.2	23	1.6	2,924
2010	291 (6.8)	1,709 (29%)	0.2	18	4.3	8,956
2020	294 (8.7)	1,996 (36%)	0.2	14	8.0	16,578

Note: Values in parentheses for defense HLW and all other values after 1982 refer to waste immobilized in glass.

Table 2

Defense Nuclear HLW Amounts in 1982

	Savannah River Plant		Idaho National Engineering Laboratory		Hanford	
	Vol., $10^3 m^3$	Activity, MCi	Vol., $10^3 m^3$	Activity, MCi	Vol., $10^3 m^3$	Activity, MCi
Liquid	73	162	9	32	34	33
Sludge	12	558	-	-	47	148
Salt Cake	30	108	-	-	98	15
Slurry	-	-	-	-	4	0.2
Calcine	-	-	2.4	40	-	0.2
Capsules (Sr-90 or Cs-137)	-	-	-	-	0.005	290
	115	828	11	72	183	486

Table 3

Defense Nuclear HLW Radionuclides in 1982, MCurie

Radio- nuclide	Savannah River Plant			Idaho National Eng. Laboratory		Hanford			
	Liquid	Sludge	Salt	Liquid	Calcine	Liquid	Sludge	Salt	Capsules
Sr-90*	3.2	255	20	8.9	9.4	1.4	130	5.6	110
Y-91	–	3.6	–	–	–	–	–	–	–
Zr-95	0.8	5.0	0.5	–	–	–	–	–	–
Nb-95	1.6	10.9	1.1	–	–	–	–	–	–
Ru-106*	1.8	12.3	1.2	0.7	–	–	–	–	–
Cs-134	–	–	–	0.5	0.1	–	–	–	–
Cs-137*	146	12.8	9.7	10.7	10.4	32	8.8	9.0	180
Cs-144*	5.8	145	3.9	8.5	–	–	–	–	–
Pm-147	2.3	72	1.5	2.4	0.5	–	8.0	–	–
Sm-151	–	–	–	–	–	–	0.9	–	–

* short-lived radioactive progeny equal in amounts to Sr-90, and Cs-144, Ru-106, and 92% of Cs-137 are included.

Notes: 1. The following are also present at lesser amounts (10^2–10^5Ci):(SRP) Sr-89; (INEL) Eu-154; (HAN) C-14, Co-60, Ni-63, Zr-95, Nb-95, Tc-99, Ru-Rh-106, Eu-154, Pu-239, Pu-240, Pu-241, Am-241, Cm-244

2. Hanford also has slurry HLW that contain 0.2 MCi Cs-137

Table 4

Chemical Composition of Defense Nuclear HLW in 1982

Savannah River Plant:

Liquid*

OH^- 3 M
NO_2^- 0.8 M
NO_3^- 3 M
$Al(OH)_4^-$ 0.8 M
CO_3^{-2} 0.2 M
Na^+ 7 M
others: F^-, Cl^-, CrO_4^{-2}
SO_4^{-2}, PO_4^{-3}

Sludge

$Fe(OH)_3$ 26%
MnO_2 4.5%
$UO_2(OH)_2$ 2.9%
$Al(OH)_3$ 31%
$AlO(OH)$ 11.6%
$CaCO_3$ 3.4%
$Ni(OH)_2$ 1.7%
ThO_2 3.9%
$NaNO_3$ 2.5%
$NaOH$ 2.9%
Zeolite 3.3%
others (<1%): $CaSO_4$; CaC_2O_4
HgO, SiO_2, $Ce(OH)_3$, $ZrO(OH)_2$,
$Cr(OH)_3$, $Mg(OH)_2$

Salt cake

$NaNO_3$ 64%
$NaOH$ 3.3%
$NaAl(OH)_4$ 7.6%
Na_2CO_3 2.7%
Na_2SO_4 9.2%
others (<1%): $NaNO_2$,
NaF, $Na_2C_2O_4$

Table 4 cont.

Idaho National Engineering Laboratory:

Liquid**		Calcine**	
Al	0.4 M	Al_2O_3	9%
B	0.13 M	B_2O_3	2%
Ca	1.2 M	CaO	11%
Cd	0.19 M	CaF_2	25%
F^-	2.5 M	Cd	5%
H+	1.4 M	Na_2O	5%
NO_3^-	2.3 M	NO_3^-	11%
Zr	0.50 M	SO_4^{-2}	2%
others:	SO_4^{-2}	ZrO_2	26%

Hanford:

Liquid:		Sludge		Salt Cake	
$NaNO_3$	13%	$NaNO_3$	22%	$NaNO_3$	84%
$NaNO_2$	4.9%	$NaNO_2$	3.8%	$NaNO_2$	1.7%
NaOH	15%	Na_2CO_3	2.2%	NaOH	1.5%
$NaAlO_2$	12%	NaOH	5.4%	$NaAlO_2$	1.4%
organic C	2.0%	$NaAlO_2$	1.2%	H_2O	10%
Na_2CrO_4	1.3%	Na_2SO_4	1.0%		
H_2O	49%	Na_3PO_4	19%		
		$Al(OH)_3$	2.9%		
		H_2O	33%		

* Intermermediate molarity in range of values is given

**These contents apply to fluorinel waste expected from calcining to begin 1985; several different wastes exist currently from zirconium fluoride, sodium-zirconium, and stainless steel wastes.

Table 5

Typical Radionuclide Composition of Commercial HLW:

Radionuclide	MCi/m3 glass	MCi/m3 liquid
Sr-90	0.70	0.065
Ru-106	0.11	0.010
Cs-137	0.98	0.091
Ce-144	0.07	0.006
Other	2.55	0.235
Total	4.42	0.407
Other characteristics		
density, g/ml	3.0	1.24
decay heat, W/L	16.8	1.55
Volume, L/MTHM	84.7	918.
Age,year	-	5.7

MTHM: metric ton heavy metal